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Study of polylactide degradation rate in a phosphate buffer solution

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Abstract. The study of the degradation of films based on polylactide in phosphate buffer solution. The effect of the change in the molecular weight of polylactide on the polymer degradation process is shown. With an increase in the molecular weight of polylactide, there is a slight increase in the rate of degradation of the polymer.

1. Introduction

Biodegradable polymers are widely used in medicine. In the body, under the action of the internal environment, they are hydrolyzed, which leads to their gradual degradation [1-5]. It is promising to use biodegradable polymers for controlled drug delivery, and also as implants, which can be gradually replaced in the body with bone or other living tissue. Biodegradable synthetic biomaterials based on polymers of organic acids, for example, lactic (PLA, polylactide) and glycolic (PGA, polyglycolide), were among the first to be used in tissue engineering. In this case, the polymer may include one type of acid residue, and combinations thereof in various proportions. Matrices based on organic acids formed the basis for the creation of such organs and tissues as skin, bone, cartilage, tendon, muscles (striated, smooth and cordial), small intestine, etc. capable of locally delivering drugs and releasing them in a controlled manner, solving possible postoperative complications and providing concomitant pharmacotherapy [6-8].

For the materials used to create systems of controlled drug delivery, the rate of degradation is important, which is influenced by many factors: composition, molecular weight, production method, product shape, environment in which biodegradation occurs, and many others [9-11]. In this work, the rate of degradation of polylactide films of various molecular weights in phosphate buffer solution was studied.

2. Materials and methods

To create films, weights of polymers weighing 10 g (± 0.01 g) were prepared.

Chloroform with a volume of 200 ml was placed in a flask with a volume of 500 ml and heated to 800 ° C on a magnetic stirrer.

Next, the obtained weights of the polymers were dissolved to a homogeneous state in chloroform at 800 ° C for 1 hour with constant stirring using an electronic overhead stirrer.



At the end of the dissolution of the polymer, the volume of the solution was brought to 200 ml with chloroform. The resulting solution was aged for 5 minutes at 800 ° C and poured into glass trays.

Drying was carried out for 2 days in air at 37 ° C in a thermostat.

At the end of drying, the films were removed. (Table 1).

Table 1. Samples of films

№	Polymer	Molecular mass, kDa	Concentration, g per 100 ml of chloroform
1	PLA	45	5
2	PLA	90	5
3	PLA	180	5

Studies of the degradation of the obtained films were carried out according to the method according to GOST R ISO 13781-2011. Preparing samples of square shape measuring 20 by 20 mm. Dried the test sample to achieve constant mass in the desiccator under vacuum at room temperature. The mass of the studied samples was determined using an analytical balance with an accuracy of 1.0% of the total mass.

Next, the samples were placed in an inert plastic container and filled with a solution of 60 ml. Used phosphate buffered saline.

The buffer solution was prepared as follows: a 1/15 mol / l KH₂PO₄ solution prepared by dissolving 9.078 g of KH₂PO₄ in 1 l of water and a 1/15 mol / l solution of Na₂HPO₄ prepared by dissolving 11.876 g of Na₂HPO₄ · 2H₂O in 1 l of water were mixed, in volume fractions of 18.2% and 81.8%, respectively. The pH of the buffer solution was 7.4 ± 0.2. The pH of the buffer solution was measured in at least two different containers in each study period. If in at least one container the pH value was shifted beyond the established limits, the pH level in all tanks was measured and adjusted to pH 7.4 ± 0.2 using a solution with (NaOH) = 0.1 mol / l.

The containers with the solution and the sample were kept in a thermostat at a temperature of 37 ± 1 ° C for 1; 3; 7; 14; 21; 28; 60 and 90 days. For each period 3 samples were prepared.

To study the degraded sample, the filter was dried under vacuum at room temperature until constant weight was reached. Determined the mass of the filter with an accuracy of 1.0% of the total mass. Wash the degraded sample under test in deionized water three times using a filter to hold possible parts of the sample.

After that, the degraded sample and the filter were dried under vacuum at room temperature until constant weight was achieved. Determined the total mass of the sample and filter with an accuracy of 1.0% of the total mass.

3. Results and discussion

Figure 1 (a-c) shows the results of a study of the degradation of polymer films over time.

With an increase in the molecular weight of polylactide (45, 90, and 180 kDa), the degradation rate increases slightly (Fig. 1). So for 90 days for a polylactide with a molecular mass of 45 kDa, the mass loss is 6.5%, for 90 kDa - 7.8%, and for 180 kDa - 8%.

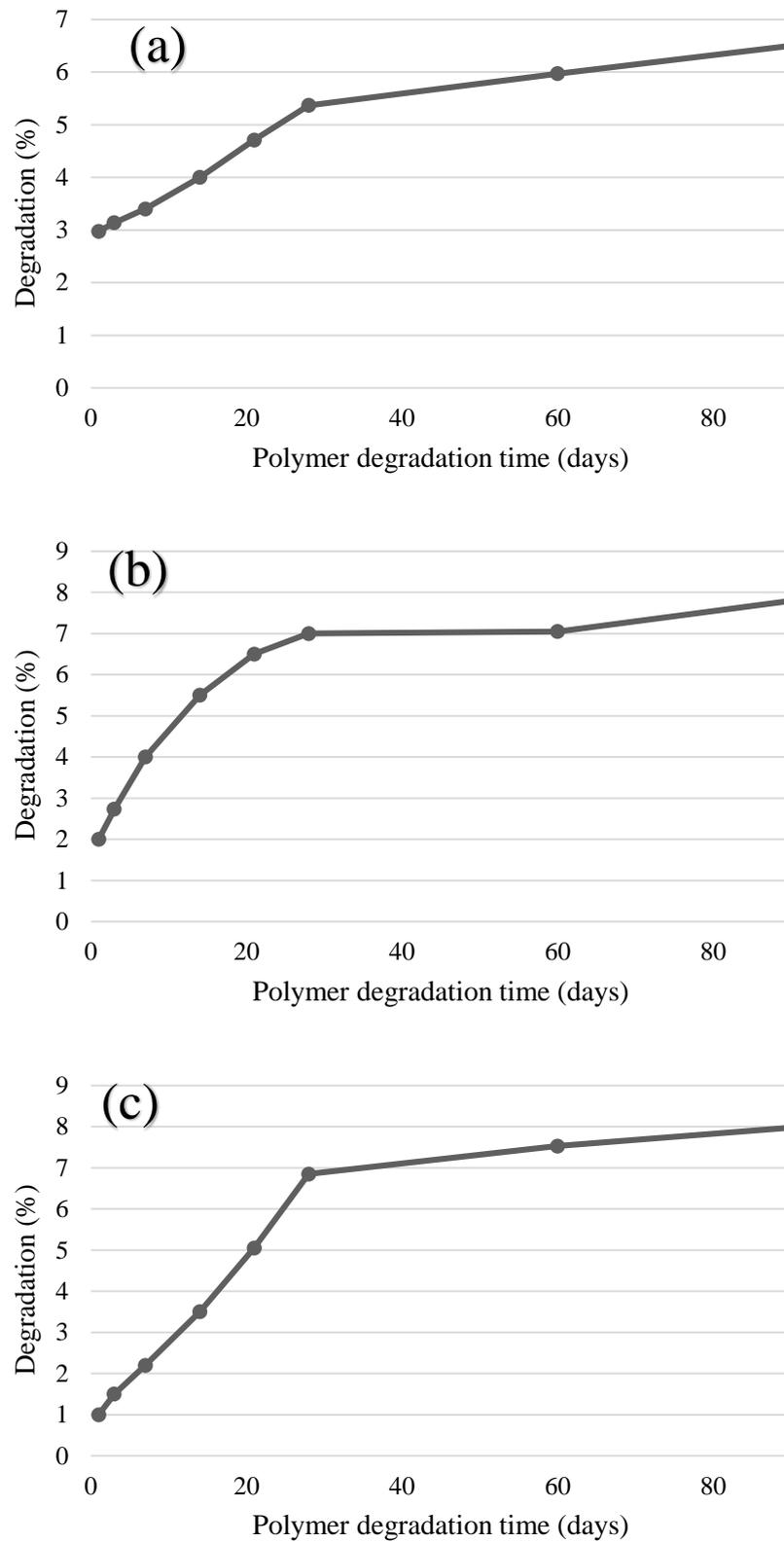


Figure 1. Dependence of the degree of degradation of films on the exposure time in phosphate buffer: a - PLA 45 kDa; b - PLA 90 kDa; c - PLA 180 kDa.

Poly lactide films acquired white color and lost transparency on day 60, and remained almost intact for 180 days (Fig. 2). It should be noted that the smallest loss of transparency was observed for samples with the greatest thickness. It can be assumed that the process of swelling, preceding the degradation of the polymer, occurs more slowly with an increase in the volume in which it should occur.

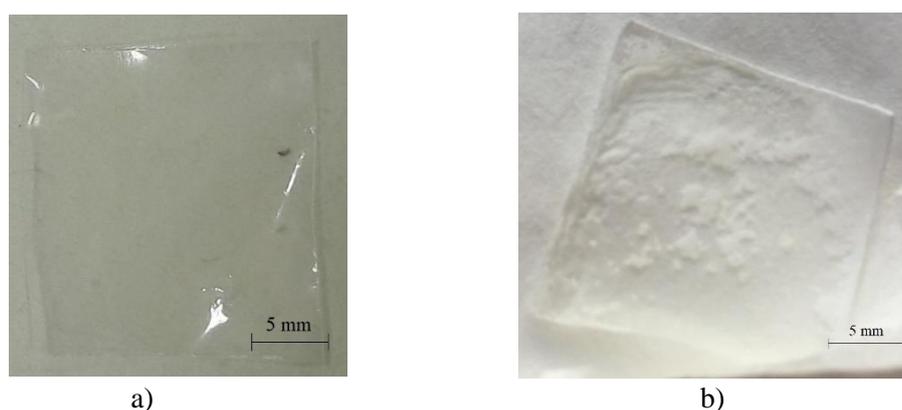


Figure 2. The condition of PLA films with a molecular weight of 90 kDa after exposure to phosphate buffer for: a) 1 day; b) 60 days

4. Conclusions

A study of the degradation of polylactidine films of different molecular weights was carried out. An increase in the molecular weight of polylactide does not significantly affect the rate of degradation of the films.

Acknowledgements

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